MODIFIED APPROACH OF HOUGH TRANSFORM FOR SKEW DETECTION AND CORRECTION IN DOCUMENTED IMAGES

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Abstract: *In optical character recognition and document image analysis skew is introduced in coming documented image. Which degrade the performance of OCR and image analysis system so to detection and correction of skew angle is important step of preprocessing of document analysis. Many methods have been proposed by researchers for the detection of skew in binary image documents. The majority of them are based on Projection profile, Fourier transform, and cross-correlation, Hough transform, Nearest Neighbor connectivity, linear regression analysis and mathematical morphology. Main advantage of Hough transform is its accuracy and simplicity. But due to slow speed many researchers work on its speed complexity without compromising the accuracy. So, for improving computational efficiency of Hough transform there are various variations have been proposed by researchers to reduce the computational time for skew angle. In this Paper we introduced new method which reduces the time complexity without compromising the accuracy of Hough transform.*

Keywords: *Hough transform, OCR, skew detection.*

I. INTRODUCTION

Document image processing has become an increasingly important technology in the automation of office documentation tasks. Automatic document scanners such as text readers and OCR (Optical Character Recognition) systems are an essential component of systems capable of those tasks. One of the problems in this field is that the document to be read is not always placed correctly on a flatbed scanner. This means that the document may be skewed on the scanner bed, resulting in a skewed image. Skew is any deviation of the image from that of the original document, which is not parallel to the horizontal or vertical. Skew Correction remains one of the vital parts in Document Processing. Many methods have been proposed by researchers for the detection of skew in binary image documents [1]. This skew has a detrimental effect on document analysis, document understanding, and character segmentation and recognition. Consequently, detecting the skew of a document image and correcting it are important issues in realizing a practical document reader. It included the skew which degrade the performance OCR system. So, to increase the performance of OCR system we must detect the skew as well as correct the skew. Normally, when skew is detected and main work is done by researchers to rotate into opposite direction. There are various methods for detecting the skew which are like projection profile, Fourier transform, Hough transform, nearest neighbour connectivity, linear regression analysis and mathematical morphology so different researchers have to use different methods to solve this problem. Main advantage of Hough transform is its accuracy and simplicity. But due to slow speed many researchers work on its speed complexity without compromising the accuracy. So, for improving computational efficiency of Hough transform there are various variations have been proposed by researchers to reduce the computational time for skew angle. There are basically three types of skew in the images like on the basis on number of skew angle and orientation three types of skew upcoming in scanning the document:

1. Global Skew: this come when document have common degree angle orientation.
2. Multiple Skew: documents have different degree of orientation in the different contents.
3. Non-uniform text line skew: when documents contain several orientation in the single line [11].

Figure 1 Skewed image with 2 degree angle

Figure 1 is skewed images which are deflected from its normal angle by 2 degree as shown. In Figure 2, the skew angle is removed and hence we get the images in its correct form. There are various methods available for the detection and correction of skew angle. Each and every method has own advantages and disadvantages on the basis of we can calculate the efficiency of any particular algorithm.

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Firstly algorithms efficiently computing [...]
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angular resolutions. Amin and Fischer us[...]
stage blocks of HXT like captions of pic[...]
the skew angle for each blocks and fitt[...]
increasing the speed only bottom line of[...]
Hough transform firstly and determine bl[...]
Manjunth at a (2006) also used Hough t[...]

Figure 2.Documented image by rotation 2 degree angle

II. RELATED WORK

Generally, there are a variety of global skew detection and correction techniques available. Most of these techniques are reviewed by Hull [1]. Broadly skew estimation approaches are classified into basic categories. It includes projection profile, Hough transforms, nearest neighbour clustering, and cross correlation. Historically, Hough transform based document skew detection and correction are proposed in Srihari and Govindaraju (1989) [2]. They calculate Hough transform at all angles of θ between 0 and 180. A heuristic measures the rate of change in accumulator values at each value of θ. The skew angle is set to the value of theta that maximizes the heuristic [3]. Hinds et al. (1990) use Hough transform and run length encoding to estimate the document skew. Additionally, they reduce data with the use of horizontal and vertical run length computations. The document image, acquires at 300 dpi, is under sampled by a factor of 4 and transformed into a burst image. This image is built by replacing each vertical black run with its length placed in the bottom-most pixel of the run. The Hough transform is then applied to all the pixels in the burst image that have value less than 25, aiming at discarding contributes of non-textual components[4]. The bin with maximum value in the Hough space determines the skew angle Jiang et al. used Hough transform with detecting points in coarse form and accurate skew is obtained by choosing peak value for skew angle [5]. Yu and Jain used a fast and accurate approach on set of low resolution images. They use hierarchical Hough transform and centroids of connected components. Firstly algorithms efficiently computing connected components and at their

centroids by using block adjacency graph then Hough transform is applied to centroids using two angular resolutions[6] Spitz et al. used the data reductions techniques that used for compressed images, in which data points are obtained with single pass and mapped into Hough space [7]. Chaudhary and Pal have proposed a technique for Indian language scripts in which exploits the inherent properties of the script to determine the skew angle. The idea is to detect skew angles of these head lines of scripts. The method detecting skew angles in range (-45° to 45°) [8]. Amin and Fischer (2000) apply Hough transform to de-skew the document image in two stages. First, blocks of text, such as paragraphs and captions of pictures are identified. Next, they calculate skew angle for each block by fitting straight lines using least square method, only the bottom line of a block is considered for skew detection in order to enhance the speed [9]. Singh et al. have purposed new algorithm which speeds up the performance of classic Hough transform. Mainly, this new algorithm converts the voting procedure to hierarchy based voting method which speeds up the performance and reduce the space requirements. They perform fast Hough transform in which three sub processes are done. Firstly in pre-processing stage block adjacency graph is used. Then in voting process done using Hough transform and at finally, skew angle is corrected by rotation. But BAG based algorithm is found to be effective for Roman Scripts documents and is not satisfactory for Indian scripts where headline is part of the script. So, this approach is script dependent [10]. Manjunath et al. [11] also used Hough transform to detect the skew angle in two steps. Initially, they identified character blocks from document images and thinning process is performed over all regions. Then next thinned conditions are fed to Hough transform. The primary disadvantage of this technique is that time complexity does not include the thinning process time. Ruilin Zhang et al. uses the Hough transform in fabric images for skew detection using the multi-threshold analysis [12]. The principal of Hough transform for skew detection is analyzed in this paper and describes how to apply the method of using Hough transform combining with the Sobel operator in skew detection.

III. HOUGH TRANSFORM

Firstly Hough transform is the linear transform for detecting straight lines. In the image representation there is image space, in which the straight line can be represented by equation $y = mx + b$ and can be graphically plotted for each pair of image points (x, y). In the Hough transform, the main idea is to consider the characteristics of the straight line not as image points x or y, but in terms of its parameters, here the slope parameter m and the intercept parameter b. Based on that fact, the straight line $y = mx + b$ can be represented as a point (b, m) in the parameter space. However, one faces the problem that vertical lines give rise to unbounded values of the parameters m and b. For computational reasons, it is therefore better to

parameterize the lines in the Hough transform with two other parameters, commonly referred to as ρ (rho) and θ (theta). In which line can be represented Cartesian equation x .cos θi + y. sin θi = ρi .Where the parameter ρ represents the distance between the line and the origin, and θ is the angle of the vector from the origin to this closest point. Figure 3 shows the parameter plane of ρ and θ. In which X and Y are axis and ρ is distance and θ the angle .but the Cartesian equation is slow for accumulating process than slope and intercept equations.
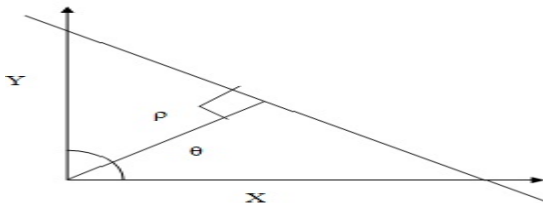

Figure 3 parameter plane of ρ and θ

The Hough transform accepts the input in the form of a binary edge map and find edges which are positioned likes straight lines. The idea of the Hough transform is that every edge point in the edge map is transformed to all possible lines that could pass through that point. The line detection in a binary image using the Hough transform algorithm is below:

1. Select the Hough transform parameters ρmin, ρmax, θmin and θmax.
2. Quantize the (ρ,θ) plane into cells by forming an accumulator cell array A (ρ,θ), where ρ is between ρmin and ρmax, and θ is between θmin and θmax.
3. Assigning the element of an accumulator cell array A to zero.
4. For each black pixel in a binary image, perform the following:

   For each value of θi from min to max, calculate the corresponding ρi using the equation: x .cosθi + y. sin θi = ρi Round off the ρi value to the nearest allowed ρ value. Updating the accumulator array element A (ρi, θi) by voting procedure.
5. In last, local maxima in the accumulator cell array correspond to a number of points lying in a corresponding line in the binary image.

The running cost is O (n×A), where n is number of points and A is number of different values of angles. So more accuracy we need, then more fine angle intervals we have to use and hence more different values for angle, and more the running time.

IV. METHODS FOR INCREASE THE SPEED OF HOUGH TRANSFORM

1. Converting floating operations to integer operations: - in this method we converted the floating point operations into integer operations which increase the speed of Hough transforms .but accuracy is affected so maintain the accuracy we

   must use the nearest integer results of float operation
2. Pre-computations:- Many operations which are repetitive in detecting skew angle. That can be precomputed and stored into array so in this way we reduced the number of calculations.
3. Using Hierarchical approach:-The main idea of the above methods is to reduce the amount of Input data. In this method researchers used coarser Hough space in which only rough estimate is considered. This approach is equally suitable for handwritten documents. [6].
4. Using BAG algorithm: - In this method input data is reduced by taking centroids of connected components rather than use of all image pixels [11].
5. Rotation: - Singh at al [2008] shows that there are two type of rotation which is forward rotation inverse rotation. We generally expect that results of both rotations are same but he has observed that results are not same .So he concluded that time taken by forward rotation is less than inverse rotations. But quality of rotated images is higher in inverse rotation than forward rotation at special conditions.

V. PROPOSED SOLUTION

Our skew detection approach will be based on a technique involving Modified Hough Transform to detect the skew. We apply Hough transform (HT) to the set of pixels. We apply HT with a modified technique so that the total time taken by the algorithm gets reduced keeping the accuracy of the process intact. We divide the spectrum of the HT space i.e., angle of skew which can be 0 degree to 45 degree into one-tenths, thus getting the portion in which the resultant skew lies. Then only that portion is further investigated by diving it into one-tenths and so on. This way the algorithm reaches the solution quickly as compared to the classical HT.
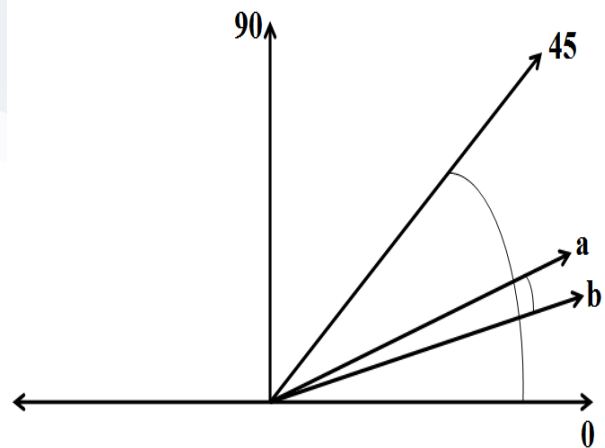

Figure 4: Representation of the proposed technique.

Figure 4 depicts the proposed process. First HT is applied for angles from 0 degree to 45 degree with a step of 4.5 degrees. Assume that the portion that attracts the maximum votes is the angle from a degree to b degree. Then, only the portion from a to b degrees is further explored using HT with higher resolution.

VI. CONCLUSION

There are different methods for document image skew detection. These included projection profiles which used different angles directly from image data, methods that calculated projection profiles from image features, and second algorithms that used the Hough transform. On which we calculated the skew angle for straight Line and other parametric curves another class of technique extracted features with local, directionally sensitive masks. The Speed of Hough transform is slow but have anti interference capability so it is used mostly in this paper we reviewed various variations of Hough transform each methods have their own speed for different scripts .Only preliminary efforts have been conducted in comparative performance evaluation. Further work in this area could help show the performance of proposed solution.

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